

Claims

1. A method for sensing gases using a semiconductor diode laser spectrometer, the method comprising:
5 introducing a sample gas into a non-resonant optical cell; applying a step function electrical pulse to a semiconductor diode laser to cause the laser to output a continuous wavelength chirp for injecting into the optical cell; injecting the wavelength chirp into the
10 optical cell; using the wavelength variation provided by the wavelength chirp as a wavelength scan, and detecting light emitted from the cell, wherein a chirp rate is selected to substantially prevent light interference occurring in the optical cell.
- 15 2. A method as claimed in claim 1, wherein the duration of the pulse applied to the semiconductor diode laser is equal to or less than one microsecond.
- 20 3. A method as claimed in claim 1 or claim 2, wherein the duration of the pulse is less than the duration necessary for the optical output power to become zero after the drive pulse has been applied.
- 25 4. A method as claimed in any of the preceding claims further involving varying the rate of change of wavelength per unit time, for example by varying the amplitude of the current/voltage drive pulse.
- 30 5. A method as claimed in any of the preceding claims comprising adjusting the wavelength scan length, for example, by varying the duration of the current/voltage drive pulse.
- 35 6. A method as claimed in any of the preceding claims comprising varying the semiconductor diode laser temperature.

REPLACED BY
ART 34 AMDT

BEST AVAILABLE COPY

7. A method as claimed in any of the preceding claims, wherein the semiconductor diode laser has output radiation having wavelengths in the region of 1 μ m to 14 μ m.

8. A method as claimed in any of the preceding claims wherein the semiconductor laser is a quantum cascade laser.

9. A method as claimed in any of the preceding claims, wherein the cell is a Herriot cell.

10. A semiconductor diode laser spectrometer, preferably a quantum cascade laser spectrometer, for measuring radiation absorption by a sample, the spectrometer comprising a semiconductor diode laser; a non-resonant optical cell for containing a sample gas; an electric pulse generator adapted to apply a substantially step function electrical pulse to the laser to cause the laser to introduce a continuous wavelength chirp into the sample cell at a chirp rate that is selected to substantially prevent light interference occurring in the optical cell, and a detector for detecting light output from the cell and adapted to use the wavelength variation of the wavelength chirp as a wavelength scan.

11. A spectrometer as claimed in claim 10, wherein the duration of the electrical pulse is equal to or less than 1 microsecond.

12. A spectrometer as claimed in claim 10 or claim 11, wherein means are provided for varying the rate of change of wavelength per unit time of the chirp, for example means for varying the amplitude of the current/voltage drive pulse.

RECEIVED
12 001

BEST AVAILABLE COPY

13. A spectrometer as claimed in claimed in any of claims 10 to 12 wherein means are provided for adjusting the wavelength scan length, for example by varying the duration of the electrical pulse.

5

14. A spectrometer as claimed in claimed in any of claims 10 to 13 wherein means are provided for varying a starting wavelength point of the wavelength scan.

10

15. A spectrometer as claimed in claimed in claim 14, wherein the means for varying a starting wavelength point are operable to vary the semiconductor diode laser base temperature.

15

16. A spectrometer as claimed in claimed in claim 15, wherein the means for varying the temperature of the semiconductor diode laser comprise a thermoelectric heater/cooler or means for adjusting the duty cycle or the pulse repetition frequency of the repeated current/voltage drive pulses applied to the electrical contacts of the laser diode or means for adjusting the pulse amplitude of the current/voltage drive pulses or means for adjusting the base DC level of the current/voltage drive pulses applied to the electrical contacts of the laser diode.

20

25

30

17. A spectrometer as claimed in claimed in any of claims 10 to 16, wherein the amount of radiation absorbed is determined using an amplitude measurement of radiation transmitted through the sample and an amplitude measurement of a reference pulse.

35

18. A spectrometer as claimed in claimed in any of claims 10 to 17, wherein a beam splitter or other like element is provided to split radiation output from the laser into

two components, the first component for passing through the sample and a second component that does not pass through the sample.

5 19. A spectrometer as claimed in claimed in any of claims 10 to 18, wherein the semiconductor diode laser emits radiation having wavelengths in the region of $1\mu\text{m}$ to $14\mu\text{m}$.

10 20. A spectrometer as claimed in claimed in any of claims 10 to 19, wherein the optical cell is a Herriot cell.

15 21. A method for sensing unconfined gases using a semiconductor diode laser spectrometer, the method comprising: applying a substantially step function electrical pulse to a semiconductor diode laser to cause the laser to output a continuous wavelength chirp; injecting the wavelength chirp sequentially through the gas; using the wavelength variation provided by each wavelength chirp as a wavelength scan, and detecting
20 light transmitted through the cell by sampling each pulse received across a spectral region.

25 22. A chemical finger-printing method for identifying gases using a semiconductor diode laser spectrometer, the method comprising: applying a substantially step function electrical pulse to a semiconductor diode laser to cause the laser to output a continuous wavelength chirp; injecting the wavelength chirp into the gas; using the
30 wavelength variation provided by each wavelength chirp as a wavelength scan; detecting light transmitted through the gas by sampling a received pulse across a spectral range; and using the detected signal to provide a chemical finger print of the gas.

35

23. A method as claimed in claim 22, wherein the chirp has a frequency variation of about 60GHz.

24. A method as claimed in claim 22 or claim 23, wherein the applied pulse has a duration that is greater than 150ns, in particular greater than 200ns.

5

25. A method as claimed in claim 22 or claim 23 or claim 24, wherein the applied pulse has a duration that is in the range of 150 to 300ns, preferably 200 to 300ns.

10

RECEIVED BY
JUL 24 2007
BEST AVAILABLE COPY